(7)

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PCT

特許協力条約に基づいて公開された国際出願

(51) 国際特許分類6
H04B 1/26

A1

(11) 国際公開番号 WO96/17441

(43) 国際公開日 1996年6月6日(06.06.96)

(21) 国際出願番号 PCT/JP95/02448
(22) 国際出願日 1995年11月30日(30.11.95)

(30) 優先権データ

特願平6/297180	1994年11月30日(30.11.94)	JP
特願平7/66253	1995年3月24日(24.03.95)	JP
特願平7/278513	1995年10月26日(26.10.95)	JP

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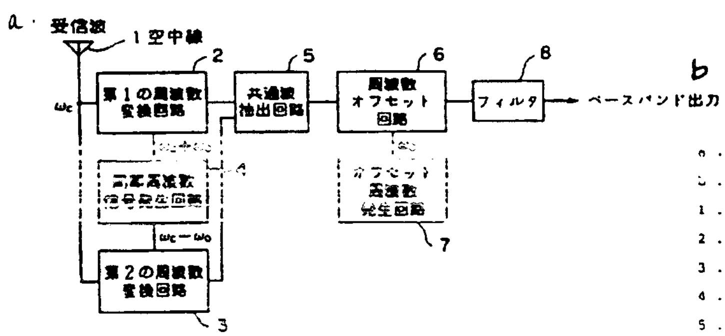
(81) 指定国
CN, SG, US, 欧州特許(AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

添付公開書類　国際調査報告書

(54) Title : RECEIVING CIRCUIT

(54) 発明の名称　受信回路



a ... received wave
b ... base band output
1 ... antenna
2 ... first frequency converting circuit
3 ... second frequency converting circuit
4 ... local frequency signal generating circuit
5 ... common wave extracting circuit
6 ... frequency offsetting circuit
7 ... offset frequency generating circuit
8 ... filter

(57) Abstract

A receiving circuit for digital demodulation communication system including channels, which reduces the power consumption of the receiving system, has a simple structure and consumes a small power. Two frequencies higher and lower the middle value of the frequencies of the channels are supplied to first and second frequency converting circuit (2 and 3) respectively from a local frequencyt signal generating circuit (4). Two output signals are generated for each of three signals of desired wave, higher channel, and lower channel. The desired wave commonly existing in the circuits (2 and 3) are extracted by means of a common wave extracting circuit (5). The frequency offset ωo in the output of the circuit (5) is removed by means of a frequency offset circuit (6) and the unnecessary frequency components are removed through a filter (8). By using a commons wave extracting circuit (5) having a transformer to utilize the mutual inductance, the difference between the common and noncommon waves is twice larger than that of conventional.

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 742 647 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
13.11.1996 Bulletin 1996/46

(21) Application number: **95938618.6**

(22) Date of filing: **30.11.1995**

(51) Int. Cl.^{6}: **H04B 1/26**

(86) International application number:
PCT/JP95/02448

(87) International publication number:
WO 96/17441 (06.06.1996 Gazette 1996/26)

(84) Designated Contracting States:
DE GB NL SE

(30) Priority: **30.11.1994 JP 297180/94**
24.03.1995 JP 66253/95
26.10.1995 JP 278513/95

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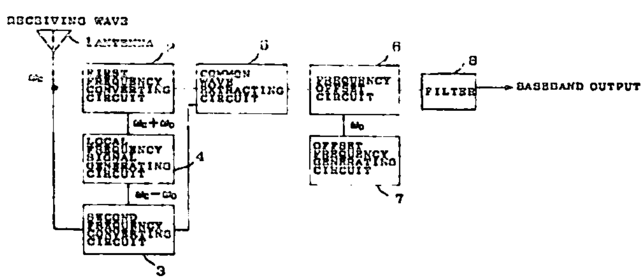
(54) RECEIVING CIRCUIT

(57) A receiving circuit mainly available in a digital modulation type communication system having a plurality of channels, which is capable of reducing power in a receiving system, simplifying the circuit and reducing the power consumption. Upside and downside frequencies corresponding to a central value between channels are separately supplied from a local frequency signal generating circuit 4 to first and second frequency converting circuits 2, 3 so that two output signals are developed with respect to one of a desired wave, upside channel and downside channel. The desired wave present in common in the first and second frequency converting circuits 2, 3 is extracted in a common wave extracting circuit 5, and a frequency offset of ωo existing in the output of the common wave extracting circuit 5 is removed a frequency offset circuit 6 and further an unnecessary frequency component is filtered by a filter 8. In addition, the common wave extracting circuit 5 has transformers and, using its inductances, raises the difference between the common wave and the non-common wave within the circuit to more than two times that of a prior art.

Fig. 1



EP 0 742 647 A1

Description

BACKGROUND OF THE INVENTION

[Field of the Invention]

The present invention relates to a receiving circuit, and more particularly to a receiving circuit which permits simplification of its circuit arrangement and which further allows less power for a receiving system concurrent with reduction of power consumption.

[Description of the Prior Art]

One of important points needed for a receiving circuit in communications is to possibly reduce high-frequency circuit portions to thereby lessen a high power consumption factor, unstable operation factor and high manufacturing cost inherent in the high-frequency circuit, coupled with a space occupied by that circuit. These points are particularly important for mobile communication systems and others. For the reduction of the high-frequency circuit portions, a direct demodulation method has been proposed heretofore in terms of multiple frequency conversion and carrier frequency, thus accomplishing the direct conversion into a low frequency and the direct demodulation into a baseband. The aforesaid high-frequency circuit portion mainly constitutes a space diversity reception function necessitating two antenna systems.

As the direct demodulation method, there have been developed a number of methods in which a local oscillator generates a signal with a frequency equal to the carrier frequency which in turn, is mixed with a received input wave to derive a baseband signal therefrom. This direct demodulation method is made to produce a high-frequency signal with a frequency equal to the received signal frequency, and the high-frequency signal can be easy to release or emit in the air through an antenna of the receiver. Accordingly, another receiver adjacent thereto undergoes interferences to be inhibited from establishing communications. For this reason, this method has chiefly been adopted for communications based on frequency modulation methods which are relatively strong to single frequency interferences.

On the other hand, radio portable telephones, being recently rapidly put in widespread use, rely on a so-called PSK which is one amplitude transport modulation method, and the single frequency interference produces an offset in a demodulated output to deteriorate the error rate of a received signal. That is, since the local oscillation frequency can not take the carrier frequency, in this kind of communication method difficulty is encountered in direct frequency conversion and direct demodulation. One approach to resolve such a technical problem involves a method which, if a carrier frequency for a radio portable telephone is taken as fc and an offset frequency is taken to be fo, obtains fc + fo and fc - fo in order to provide a frequency-offset complementary local oscillation frequency for a frequency conversion. For carrying out this method, fc + fo and fc - fo are obtainable by multiplication process of fc and fo through a mixer (frequency mixer), while both signals fc + fo and fc - fo coexist in an output. More specifically, although the aforesaid process independently requires signals with the respective frequencies, the prior system can not practically satisfy this requirement. The prior system essentially employs filters for the respective frequencies, while suffering a disadvantage that a carrier frequency for a desired signal is variable and hence the filters need to designed to cope with the frequency variations.

SUMMARY OF THE INVENTION

The present invention has been developed with a view to resolving the prior problems, and it is therefore a general object of the present invention to provide a receiving circuit in a communication system with a plurality of channels, which is capable of lessening the power necessary in a receiving system and of reducing the power consumption with a simplified circuit.

Another general object of this invention is to provide a receiving circuit which can provide the frequencies fc + fo and fc - fo for elimination of the problems related to the aforementioned ordinary methods.

More specifically, an object of this invention is to provide a receiving circuit which performs a direction frequency conversion of a frequency in between the channels of a receiving system as a local frequency of a receiver and prevents the occurrence of the frequency offset in its output signal and the mixing of a signal of the adjacent channels thereinto.

In addition, a further object of this invention is to structurally review functional parts making up a receiving circuit to reduce the functional parts suffering from a large power consumption or replace them with different ones.

For these purposes, as one example, a receiving circuit according to this invention is composed of first and second frequency converting circuits for accepting a received signal obtained through an antenna, a local frequency signal generating circuit for generating middle (intermediate) frequencies between a radio carrier frequency of the received signal and radio carrier frequencies of adjacent upside and downside channels and further for outputting the upside frequency of the upside and downside two wave frequencies as a conversion frequency input to said first frequency converting circuit and for outputting the downside frequency thereof as a conversion frequency input to said second frequency con-

verting circuit, a common wave extracting circuit for extracting a component present in common in both outputs of the first and second frequency converting circuits, a frequency offset circuit for removing a frequency offset remaining in an output of the common wave extracting circuit, and a filter for removing an unnecessary frequency component remaining in an output of the frequency offset circuit.

In addition, in this invention, a means to resolve the prior problems is added to a local frequency complementary offset type direct frequency converting system, which bases this invention. A space diversity function can be realized with a receiving circuit based on a single direct quadrature detector.

With this arrangement, a received signal obtained from an antenna is fed to the first and second frequency converting circuits, while the local frequency signal generating circuit supplies, to the first and second frequency converting circuits, two different frequencies, i.e., the upside and downside frequencies corresponding to central values between channels, thus producing two output signals in terms of each of a desired wave, an upside channel and a downside channel. Further, a desired wave channel signal being a signal component present in common in both the first and second frequency converting circuits is extracted in the common wave extracting circuit. Since a frequency offset of ωo remains in the output of the common wave extracting circuit, a minute frequency conversion is carried out in the offset frequency circuit to remove the offset amount. Moreover, an unnecessary frequency component generated in this process is removed through a filter, before the resultant signal is supplied as a baseband signal to a baseband signal processing section.

In accordance with a preferred form of this invention, a receiving circuit comprises first and second frequency converting circuits for accepting a received signal obtained through an antenna, a local frequency signal generating circuit coupled to the first and second frequency converting circuits for generating middle frequencies between a radio carrier frequency of the received signal and radio carrier frequencies of adjacent upside and downside channels and further for outputting the upside frequency of the upside and downside two wave frequencies as a conversion frequency input to the first frequency converting circuit and for outputting the downside frequency thereof as a conversion frequency input to the second frequency converting circuit, a common wave extracting circuit for extracting a component present in common in both outputs of the first and second frequency converting circuits, a frequency offset circuit for removing a frequency offset remaining in an output of the common wave extracting circuit, and a filter for removing an unnecessary frequency component remaining in an output of the frequency offset circuit.

In another preferred form of this invention, a receiving circuit comprises first and second frequency converting circuits for accepting a received signal obtained through an antenna, a local frequency signal generating circuit coupled to the first and second frequency converting circuits for generating middle frequencies between a radio carrier frequency of the received signal and radio carrier frequencies of adjacent upside and downside channels and further for outputting the upside frequency of the upside and downside two wave frequencies as a conversion frequency input to the first frequency converting circuit and for outputting the downside frequency thereof as a conversion frequency input to the second frequency converting circuit, a first frequency offset circuit for removing a frequency offset contained in an output of the first frequency converting circuit, a second frequency offset circuit for removing a frequency offset contained in an output of the second frequency converting circuit, a common wave extracting circuit for extracting a component present in common in both outputs of the first and second frequency offset circuits, and a filter for removing an unnecessary frequency component left in an output of the common wave extracting circuit.

In a further preferred form of this invention, a receiving circuit comprises first and second frequency converting circuits for accepting a received signal obtained through an antenna, a local frequency signal generating circuit coupled to the first and second frequency converting circuits for generating middle frequencies between a radio carrier frequency of the received signal and radio carrier frequencies of adjacent upside and downside channels and further for outputting the upside frequency of the upside and downside two wave frequencies as a conversion frequency input to the first frequency converting circuit and for outputting the downside frequency thereof as a conversion frequency input to the second frequency converting circuit, first quantizing means for quantizing an output of the first frequency converting circuit, second quantizing means for quantizing an output of the second frequency converting circuit, a common wave extracting circuit for extracting a component present in common in both outputs of the first and second quantizing means, a frequency offset circuit for removing a frequency offset remaining in an output of the common wave extracting circuit; and a filter for removing an unnecessary frequency component left in an output of the frequency offset circuit.

In a further preferred form of this invention, a receiving circuit comprises first and second frequency converting circuits for accepting a received signal obtained through an antenna, a local frequency signal generating circuit coupled to the first and second frequency converting circuits for generating middle frequencies between a radio carrier frequency of the received signal and radio carrier frequencies of adjacent upside and downside channels and further for outputting the upside frequency of the upside and downside two wave frequencies as a conversion frequency input to the first frequency converting circuit and for outputting the downside frequency thereof as a conversion frequency input to the second frequency converting circuit, first quantizing means for quantizing an output of the first frequency converting circuit, second quantizing means for quantizing an output of the second frequency converting circuit, a first frequency offset circuit for removing a frequency offset contained in an output of the first quantizing means, a second frequency offset circuit for removing a frequency offset contained in an output of the second quantizing means, a com-